RECOMMENDED CRITERIA FOR REPLACEMENT

Based on the findings that CI and DI mains are being replaced at a consistent rate that could meet one of several possible reasonable completion dates and that the MRI approach appears to adequately single out the problematic segments in terms of breaks and cracks, it is reasonable to conclude that the current Cast and Ductile Iron Replacement Program criteria and methodology are working effectively. The trend in cracks, breaks and leaks is downward, and progress is occurring at a rate sufficient to enable the operator to have all cast iron and ductile iron mains of sizes 12-inch and smaller replaced by 2050. Because the track record for the larger-size pipes (16-inch through 48-inch) has been good in terms of there being few breaks, cracks, or leaks associated with those sizes, one can say that extending the completion dates for the larger sizes would not significantly compromise the safety and reliability of the system. Therefore, we recommend that PGL continue with their present approach to CI and DI main replacement modified as shown below based on three different completion dates for three pipe-size categories.

RECOMMENDED SCHEDULE FOR REPLACEMENT

As has been noted we believe that PGL's approach to CI and DI replacement is working effectively. It is recalled that the average trend of replacement, considering all sizes, if continued linearly, would result in replacement of all CI and DI pipe by 2038. It is also clear that the average replacement rate that ostensibly would result in completion by 2038 is comprised of a wide range of replacement rates by size and that the current replacement rates of the larger-size pipes (16-inch and over) cannot accommodate their replacement by that date. It is noted that some of these segments if replaced at current rates will not accommodate ZEI's target date of 2050 for completion. The review described in this report reveals that the larger-size pipe segments (16-inch and over) account for less than 2 percent of the pipe breaks and less than 1 percent of the cracks. The remaining 4-inch pipe amounts to only 10.75 miles, but it is distributed over 317 segments, and therefore, it likely would not get replaced by 2015 as the polynomial extrapolation suggests. However, stretching-out its replacement likely would have little impact on safety because the absolute numbers of breaks over the last 7 years in the remaining 15 miles of this pipe amounted to only 14 (average of 2 per year) out of 1276 total breaks. As with this remaining 4-inch pipe (constituting less than 10 percent of the original mileage of this size), it is likely that some segments of the 6-inch pipe also will not be characterized by high MRI scores because they are causing very few on-going problems. Therefore, we believe that the schedule for replacement of the large-diameter segments and short residual segments of the smaller-diameter pipes that do not have high MRI scores could be extended significantly beyond 2050. Accordingly we are recommending the following:

- PGL should continue to employ the present MRI threshold score of 6 as one of their criteria for selecting segments for replacement. The declining rates of occurrences of breaks and cracks show that this is an effective criterion.
- Replacement of all segments of 4-inch, 6-inch, and 8-inch pipe should be completed by 2036 as these sizes of pipes have accounted for over 90 percent of the instances of breakage and cracking.
- Replacement of all segments of 10-inch and 12-inch pipe should be completed by 2050.
- Replacement of all segments of 16-inch and larger pipe should be completed by 2080.

We also recommend that the rate of replacement for each size to meet these goals be kept relatively constant until the amounts remaining are below 10 percent of the original mileage. If that is done, the rates of occurrences of breaks and cracks should continue to decline, and therefore, the operations and maintenance costs associated with the CI and DI mains would be expected to decline accordingly. The replacement costs per year will most likely be less under the recommended replacement scenario than they would be if all CI and DI pipe were to be phased out by the end of 2038. The replacement costs per year under the recommended scenario will be higher initially than they would be if the plan to phase out CI and DI mains by the end of 2050 were to be followed. However, the costs per year will decrease under the recommended scenario such that after 2036 they will be considerably less than they would be if the plan to phase out CI and DI mains by the end of 2050 were to be followed.

We did examine the leak history of the large diameter segments that have had internal sealants installed against those segments with no sealants to estimate the future impact of failed seals. From 1971 through 1993 approximately 59.1 miles of large diameter pipe (greater than 16-inch) had internal seals installed. To date, these seals have had an excellent leak history, with only 6 joints with sealant having leaked. If one looks at the leak history of the segments of large diameter pipe that have not been sealed, it is possible to get an idea of what to expect in terms of joint leaks if the internal sealants already installed were to break down. After 1994, the joint leak rate of large diameter pipe ranges from 0.56 to 2.13 leaks per year per mile for all the segments that have not been sealed. If one uses an average of the data, approximately 1.26 leaks per year per mile are occurring. Given that 59.1 miles of sealed-pipe exist, it would be possible in the worst case (all the sealants were to stop working) that an additional 75 leaks per year could occur.

It is not expected that the leak rate will drastically increase for the large diameter pipe, regardless of a loss of performance in the internal seals. Some of the seals have been performing satisfactorily for more than 30 years, and approximately half of the total mileage has been performing satisfactorily for 25 years.

The justification for this schedule has already been stated, namely, that it would accomplish the goal of getting rid of the CI and DI mains and that it would do so without compromising safety and reliability. Moreover, it embodies the continued use of the MRI to screen out the poorly performing segments in a timely manner.

The reasonableness of this schedule may be inferred from Table 4 above. The completion dates in Table 4 are those that would result from simple continuation of the status quo. As such, most of the 4, 6, and 8-inch segments, would be likely be replaced by 2036 under any scenario. At the present rate of replacement, most of the 12-inch pipe would be replaced by 2052. It is reasonable to conceive of accelerating its replacement to achieve completion by 2050. It is also reasonable to conceive of replacing the remaining 1.27 miles of 10-inch pipe by that date. Finally, it is reasonable to accept an extension to the schedule for replacing the larger-size pipes because these larger-size pipes account for very few breaks, cracks, or other problems. In the next section of the report we present simplified cost comparisons between our suggested schedule scenario and two other scenarios that could conceivably be followed.

IMPACT OF SCHEDULE SCENARIOS ON COSTS

The following three schedule scenarios are compared on the basis of their costs.

1. Completion in 2038 as implied by extrapolation of the trend for all pipe sizes between 1981 and 2006
2. Completion in 2050 as recommended by ZEI

3. Completion of replacement of the 4, 6, and 8-inch segments by 2036, completion of replacement of 10 and 12-inch segments by 2050, and completion of replacement of sizes 16-inch and over by 2080.

Scenario 1

This scenario is derived from the linear extrapolation of the average actual rate of replacement for all sizes of CI and DI main from 1981 through 2006 (see Figure B-1 of Appendix B). This average rate amounts to 61.81 miles per year. As was noted above in Table 4 the larger sizes of pipe are being replaced at rates considerably below this average rate. It is shown below that accelerating the rates of replacement of these larger sizes to rates that would achieve completion by 2038 would result in a significant increase in the cost per year. The good track record associated with the larger-size pipes suggests that such an accelerated rate of replacement would not significantly improve safety, and therefore it is difficult to justify the increased annual cost.

Scenario 2

This scenario can be inferred from the recommendations of the most recent ZEI study (2002). The average rate of replacement under this scenario is 44.96 miles per year. Under this scenario the rates of replacement of the most vulnerable remaining pipe (4, 6, and 8-inch) would be lower than the actual rates associated with the replacement of these sizes. In particular the replacement rate of the 6-inch pipe that has accounted for 89 percent of the breaks and cracks would be reduced from 45.39 miles per year to 30.95 miles per year. At the same time the replacement rates for the larger-size pipes would have to be accelerated without any appreciable benefit from enhanced safety.

Scenario 3

This scenario represents an attempt to keep the rates of replacement associated with the smaller-size pipes (4-inch through 8-inch) at their current levels to maintain the improving performance in terms of declining breaks and cracks, while allowing the larger-size pipes that make a negligible contribution to breaks and cracks to be replaced at slower rates without significantly increasing existing annual replacement costs.

Cost Comparisons

The cost data to be used for comparing Scenarios 1 through 3 are based on average actual costs of replacement experienced by PGL in the past and are listed in Table 5 (See Appendix C for the details of the cost per year calculations for each scenario).

Table 5. Average Cost of Replacement Based on Actual Cost Data Provided by PGL

Pipe Size, inches	Miles Remaining at end of 2006	Cost per Mile to Replace, dollars
4	10.75	526,944
6	1361.81	526,944
8	75.34	526,944
10	1.27	1,006,315
12	172.4	1,006,315
16	152.32	1,006,315
20	73.15	1,006,315
24	68.91	2,081,482
30	11.59	2,081,482
36	27.78	2,081,482
48	22.71	2,081,482

The three scenarios are summarized in Table 6.

Table 6. Summary of the Three Scenarios to be Compared on the Basis of Costs

Nominal Pipe Size	Scenario 1 Year to Complete	Scenario 2 Year to Complete	Scenario 3 Year to Complete	Miles per Year to Replace by 2038	Miles per Year to Replace by 2050	Miles per Year to Replace, Scenario 3
4	2038	2050	2036	0.34	0.24	0.36
6	2038	2050	2036	42.56	30.95	45.39
8	2038	2050	2036	2.35	1.71	2.51
10	2038	2050	2050	0.04	0.03	0.03
12	2038	2050	2050	5.39	3.92	3.92
16	2038	2050	2080	4.76	3.46	2.06
20	2038	2050	2080	2.29	1.66	0.99
24	2038	2050	2080	2.15	1.57	0.93
30	2038	2050	2080	0.36	0.26	0.16
36	2038	2050	2080	0.87	0.63	0.38
48	2038	2050	2080	0.71	0.52	0.31

The costs associated with each are presented in Table 7.

Table 7. Costs per Year, in 2006 Dollars, Associated with Each Scenario

Pipe Size, inches	Cost per Year to Replace by 2038	Cost per Year to Replace by 2050	Cost per Year through 2036 to Replace all 4-8 inch	Cost per Year through 2050 to Replace all 10-12 inch	Costs per year through 2080 to replace all 16-48 inch
4	177,026	128,747	188,828		
6	22,424,945	16,309,051	23,919,941		
8	1,240,573	902,235	1,323,278		
10	40,089	29,156		29,156	
12	5,421,380	3,942,822		3,942,822	
16	4,790,039	3,483,665			2,071,368
20	2,300,386	1,673,008			994,761
24	4,482,614	3,260,083			1,938,428
30	754,106	548,441			326,100
36	1,807,043	1,314,213			781,424
48	1,477,475	1,074,527			638,908
TOTAL	**44,915,676**	**32,665,946**	**25,432,047**	**3,971,978**	**6,750,989**

As this is a relative comparison, all costs are in 2006 dollars and projections have not been adjusted for inflation. The time value of money is not considered herein and must be determined by PGL based on their internally accepted valuation methods.

The cost per year for Scenario 1 is $44,915,676. At the end of the period of replacement, 2038, the total cost will be 30 times this amount or $1,437,301,636.

The cost per year for Scenario 2 is $32,665,946. At the end of the period of replacement, 2050, the total cost will be 44 times this amount or $1,437,301,636.

The cost per year for Scenario 3 is calculated as follows. For the period from 2007 through 2036 the cost per year will be $25,432,047 + $3,971,978 + $6,750,989 = $36,155,014. For the period from 2037 through 2050 the cost per year will be $3,971,978 + $6,750,989 = $ 10,722,967. For the period from 2050 through 2080 the cost per year will be $6,750,989. At the end of the period of replacement, 2080, the total cost will be 30 times $36,155,014 plus 14 times 10,722,967 plus 30 times $6,750,989. This amounts to $1,437,301,636

The total cost for each scenario is the same, but the annual costs of each scenario are quite different. To summarize:

- The cost per year for Scenario 1 is $44,915,676.

- The cost per year for Scenario 2 is $32,665,946.
- The cost per year for Scenario 3 is $36,155,014 until the end of 2036, $10,722,967 from 2037 through 2050, and $6,750,989 from 2051 through 2080.

Scenario 3 results in a reasonable cost per year that affords the fastest rate of replacement of the most vulnerable pipe sizes (4-inch through 8-inch), while significantly extending the replacement period for the larger diameter pipe with no negative impact on safety.

APPENDIX A
MRI MODEL

Main Ranking System

Overview:

The Main Ranking System was developed to identify and prioritize gas main segments as candidates for replacement. Each individual segment is evaluated, based on its maintenance history. Criteria taken into account include breaks, crack at taps, pipe wall thickness based on pipe coupons, visual observation, incidence of leak and other repairs. Each of these criteria is assigned a multiplication factor based on "Break Equivalents" which is than multiplied by the number of occurrences.

The sum of the aforementioned numerical value is then multiplied by a factor based on pipe material, operating pressure, diameter, street type and pavement cover. The result of this calculation is a value that is assigned to each segment known as the Main Ranking Index (MRI). The MRI value is rounded to the nearest quarter point, (i.e. The Uniform Main Rank Index (UMRI)) and sorted in descending order in order to identify those segments with the highest incidence of UMRI points per block.

All segments that have accumulated a UMRI rating greater than 6.0 are placed on a schedule to be retired. Segments with a UMRI value greater than 3.0 are viewed as possible replacement candidates when performing work on adjacent segments and when evaluating the extent of Public & System Improvement projects.

Basis of Formula:

The formula used to compute the **Main Ranking Index (MRI)** per block for each main segment is as follows:

$$\mathbf{MRI = B + C + VPE + KU + RE}$$

Where:

B = Break equivalent based on breaks.

C = Break equivalent based on cracks at taps.

VPE = Break equivalent based on visual observations of the main.

KU = Break equivalent based on pipe coupon analysis on the segment.

RE = Break equivalent based on repairs done on the main.

(See Appendix "A" for detailed formula criteria)

Definitions:

Breaks	A Break is defined as a 100% circumferential separation of pipe.
Break Equivalent	A Break Equivalent is a weighting factor assigned to each ranking category (B, C, VPE, KU and RE) in order to achieve a comparable balance.
Coupon Analysis	A coupon analysis is a defined as a physical sample that is obtained from the gas main and evaluated in a lab for thickness and weight.
Cracks at Tap	A crack is defined as having less than a 100% circumferential separation of pipe. Cracks are usually located at service taps and on bell joint ends.
MRI	The Main Ranking Index (MRI) is a summation of main factor values (B, C, VPE, KU and RE) assigned to a main segment to indicate rank order. Higher numbers indicate greater maintenance activities.
Main Ranking System	The Main Ranking System is a computer program utilized for calculating, querying and reporting the main segment ranking index as well as identifying all associated maintenance activities that make up the rating.

Repairs	Includes all maintenance activities associated with a segment. (Excludes leak repairs captured under the Breaks and Cracks categories).
UMRI	Rounding factor (MRI rounded to the nearest quarter point).
Visual Observation	Visual inspection of a segment (Good versus Poor). This category is logged whenever maintenance is performed on a segment.
Segment	A Gas Main Segment is a unique unit of pipe identified by: year installed, pressure, size, material, in-street and square mile boundary. Since segments can range in length from one (1) foot to a mile (5,280 feet), the MRI takes this into account and recalibrates the segments based on a one block length (660 feet).

Derivations of the Break Equivalents B, C, VPE, KU and RE:

B – Break Equivalent Based on breaks:

(Analysis includes number of breaks, operating pressure, street classification (business versus residential), and pavement coverage multiplied by a Break Equivalent Factor).

$$B = K_1 * B_1 * MR_{20}$$

C – Break Equivalent Based on Cracks at Taps:

(Analysis includes number of cracks at taps, operating pressure, street classification (business versus residential), and pavement coverage multiplied by a Break Equivalent Factor.)

$$C = K_2 * C_1 * MR_{20}$$

VPE – Break Equivalent Based on Visual Observations of the Main:

(Analysis is based on a visual inspection ((Poors versus Goods) (or coupon analysis if available)) and also takes into account material, operating pressure, main size, street classification (business versus residential), pavement coverage multiplied by a Break Equivalent Factor.)

For Low Pressure:

If KU = 0 (coupon analysis has not been performed)

Then

$$VPE = MIN\ [1, MATL\_FACT * MR_{10}] * MIN\ [(B + C + (1 * STR\_FACT)), VP_1 + VP_2]$$

Else (coupon analysis has been performed)

$$VPE = MIN\ [1, MATL\_FACT * MR_{10}] * MIN\ [(B + C + KU + (2 * STR\_FACT)), VP_1 + VP_2]$$

For Medium or High Pressure:

If KU = 0 (coupon analysis has not been performed)

Then

$$VPE = MIN\ [(B + C + (1 * MR_{11} * STR\_FACT)), VP_1 + VP_2]$$

Else (coupon analysis has been performed)

$$VPE = MIN\ [(B + C + KU + (2 * MR_{11} * STR\_FACT)), VP_1 + VP_2]$$

KU – Break Equivalent Based on Pipe Segment Coupon Analysis:

(Analysis includes physical evaluation of material condition, operating pressure, street classification (business versus residential), and pavement coverage multiplied by a Break Equivalent Factor.)

$$KU = K_5 * MR_5 * MR_{20}$$

RE – Break Equivalent Based on Repairs Performed on the Main Segment:

(Analysis is based on a visual inspection (Poors versus Goods)and also takes into account material, operating pressure, main size, street classification (business versus residential), pavement coverage and (or coupon analysis if available) multiplied by a Break Equivalent Factor.)

$$RE = MIN\ [(LR + OR), (2 * MR_{20})]$$

The method of calculating LR and OR depends on the material and operating pressure of the main segment.

If the main is low pressure, and not Cast Iron or Ductile Iron, then:

$LR = (K_6 * MR_6 * MR_{20} * MR_{10})$, and
$OR = (K_7 * MR_7 * MR_{20} * MR_{10})$.

If the main is medium or high pressure, and not Cast Iron or Ductile Iron, then:

$LR = (K_6 * MR_6 * MR_{20})$, and
$OR = (K_7 * MR_7 * MR_{20})$.

For Cast Iron and Ductile Iron mains LR and OR depends on operating pressure and the number of un-repaired Joints.

Joints:
If the year of main installation is < 1932
then
Joints (number of joints) = (Length of main / 12),
else
Joints (number of joints) = (Length of main / 16).

For low pressure Cast or Ductile Iron main,

and where $(MR_6 + MR_7) \leq 0.5 * Joints$
Then, $LR = (K_6 * MR_6 * MR_{20} * MR_{10})$,
And, $OR = (K_7 * MR_7 * MR_{20} * MR_{10})$.

For medium or high pressure Cast or Ductile Iron main,

and where $(MR_6 + MR_7) \leq 0.5 * Joints$
Then, $LR = (K_6 * MR_6 * MR_{20})$,
And, $OR = (K_7 * MR_7 * MR_{20})$.

For medium or high pressure Cast or Ductile Iron main,

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Where: $(MR_6 + MR_7) > 0.5 * Joints$
Then, Un-repaired Joints = Joints - $(MR_6 + MR_7)$
However, if calculated un-repaired Joints ≤ 0 from above formula then un-repaired joints = 0

$L_1 = MR_6 * (\text{Un-repaired Joints} / (MR_6 + MR_7))$
$R_1 = MR_7 * (\text{Un-repaired Joints} / (MR_6 + MR_7))$

For low pressure Cast or Ductile Iron main,

and where $(MR_6 + MR_7) > 0.5 * Joints$
Then, $LR = (K_6 * L_1 * MR_{20} * MR_{10})$,
And, $OR = (K_7 * R_1 * MR_{20} * MR_{10})$.

For medium or high pressure Cast or Ductile Iron main,

and where $(MR_6 + MR_7) > 0.5 * Joints$
Then, $LR = (K_6 * L_1 * MR_{20})$,
And, $OR = (K_7 * R_1 * MR_{20})$.

APPENDIX A

Formula Details:

Constants used in calculating break equivalents are:

K_1 = 1.0 associated with B.

K_2 = 0.5 associated with C.

K_3 = 0.5 associated with VPE.

K_4 = 1.0 associated with VPE.

K_5 = 1.0 associated with KU.

K_6 = 0.1 associated with RE.

K_7 = 0.01 associated with RE

Definitions of other terms and factors used in calculating break equivalents are:

B_1 = Number of breaks repaired on the main segment (excludes third party damage).

C_1 = Number of cracks at tap repaired on the main segment (excludes third party damage).

C_2 = Number of pipe coupons analyzed on the main segment.

C_3 = Sum of thickness of all coupons taken on the main segment.

C_4 = Average thickness of all coupons taken on the main segment.

C_5 =Sum of break equivalents assigned to the main segment based on each pipe coupon analyzed (See **Appendix B** for definition of method to assign break equivalents to coupons).

P_1 = Number of visually observed "poors" based on maintenance performed before 1990.

G_1 = Number of visually observed "goods" based on maintenance performed before 1990.

P_2 = Number of visually observed "poors" based on maintenance performed after 1989

G_2 = Number of visually observed "goods" based on maintenance performed after 1989.

L_1 = Number of leak repairs recorded in maintenance data (the reason for work is leak).

R_1 = Number of repairs recorded in maintenance data for reasons other than leak (and for work types other than test holes and internal clamping)

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MR_3 = Factor based on the number of visual "poors" versus" goods" observed during maintenance prior to 1990.

$$MR_3 = P_1 * (P_1/ (P_1 + G_1)) \text{ providing } P_1 > 0, \text{ else } MR_3 = 0$$

MR_4 = Factor based on the number of visual "poors" versus" goods" observed during maintenance after 1989.

$$MR_4 = P_2 * (P_2/ (P_2 + G_2)) \text{ providing } P_2 > 0, \text{ else } MR_4 = 0$$

MR_5 = Factor based on pipe wall thickness from each pipe coupon taken from the main segment.

$$\text{If } (P_1 + P_2 + G_1 + G_2) > 0 \text{ and } (P_1 + P_2) / (P_1 + P_2 + G_1 + G_2) \geq 0.5$$

Then

$$MR_5 = C_5 * [(P_1 + P_2) / (P_1 + P_2 + G_1 + G_2)$$

else

$$MR_5 = 0.5 * C_5$$

MR_6 = Factor based on the number of leak repairs made on the main segment.

$$\text{If } (L_1 - B_1 - C_1) > 0$$

Then

$$MR_6 = L_1 - B_1 - C_1$$

Else

$$MR_6 = 0$$

MR_7 = Factor based on the number of repairs made on the main segment for reasons other than leaks, and for work types other than test holes or internal clamping (planned upgrading).

$$\text{If } R_1 \geq 0$$

then

$$MR_7 = R_1$$

else

$$MR_7 = 0$$

MR_{10} = Factor based on the pipe diameter of the main segment.
FOR CAST IRON MAIN SEGMENTS it reflects the decreasing likelihood large diameter cast iron main will break due to increased beam strength of the pipe. Nominally shall be 6 divided by the diameter of the main in inches. However, the upper limit shall be 2.0 and the lower limit shall be 0.2. Thus the following values shall be used:
For pipe diameter less than 4" use 2.0; for 4" use 1.5; for 6" use 1.0; for 8" use 0.75; for 10" use 0.6; for 12" use 0.5; for 16" use 0.4; for 20" use 0.3; for 24" use 0.25; and for 30" and larger use 0.2.
FOR MAINS OF MATERIALS OTHER THAN CAST IRON:
For ductile iron use 0.5 time the cast iron value for the same diameter with a lower limit of 0.2.
For coated steel and polyethylene plastic use 0.4 times the cast iron value for the same diameter with a lower limit of 0.2.
Only nominal amounts of mains exist other than coated steel, polyethylene plastic, cast and ductile iron. Use 2.0 for all diameters of these mains which are primarily of only from 1 to 4 inches in diameter. (CAB, bare steel, and copper).

MR_{11} = Factor based on the operating pressure of the main segment.
Use 1.0 for low pressure mains (≤ 12" W.C.)
Use 2.0 for medium pressure mains (> 12" W.C. and < 25 PSIG)
Use 3.0 for high pressure mains (≥ 25 PSIG)

MR_{12} = Factor based on the street type in which the main segment is laid.
Use 1.0 for residential streets
Use 1.2 for business streets

MR_{13} = Factor based on the. percent of pavement cover between the main and buildings.
Use 1.0 for mains with < 50% paving from main to building.
Use 1.2 for mains with ≥ 50% paving from main to building.
Use 1.0 for mains where percent paving is not established (the field is blank).

MR_{14} = Factor to adjust main segment length to a per block basis.
Shall be 660 feet divided by the length of the main segment in feet, providing that the result is less than 1.0, else shall be 1.0.

MR_{20} = MR_{11} * MR_{12} * MR_{13} * MR_{14}

VP_1 = K_3 * MR_3 * MR_{20}

VP_2 = K_4* MR_4 * MR_{20}

STR_FACT = MR_{12} * MR_{13}

MATL_FACT = 2.0 for ductile iron mains and 1.0 for every other main material

APPENDIX A

DEFINITION OF PIPE COUPON THICKNESS POINTS BASED ON WALL THICKNESS OF COUPONS FOR CAST AND DUCTILE IRON MAINS

The minimum tolerable wall thickness for selected diameter cast and ductile iron mains is based on 2'-0" of frost and a buried depth of 3'-6". The minimum wall thickness varies with material, diameter and beam length. For a given material and diameter, the minimum wall thickness varies with the length of pipe between supporting blocking. Since PGL purchased cast iron in 12' lengths prior to 1932 and 16' lengths after 1931 the table below specifies minimum wall thickness for cast iron in both lengths as well as for ductile iron pipe in 16' lengths. The minimum values for wall thickness for pipe sizes and material were derived based on ring crushing failure and beam loading equations.

TABLE NO.1
FOR CAST AND DUCTILE IRON MAINS

MINIMUM TOLERABLE WALL THICKNESS IN INCHES

NOMINAL MAIN DIAMETER	PRE-1932 CAST IRON (11' SPANS)	POST-1931 CAST IRON (14' SPANS)	ALL DUCTILE IRON (14' SPANS)
4"	0.340"	NA	NA
6"	0.333"	0.329".	0.089"
8"	0.240"	0.237"	0.075"
10"	0.191"	0.189"	NA
12"	0.217"	0.191"	0.110"
16"	0.286"	0.251"	0.145"
20"	0.355"	0.312"	0.180"
24"	0.422"	0.372"	0.214"
30"	0.520"	0.458"	0.263"
36"	0.623"	0.548"	0.315"
48"	0.827"	0.727"	0.418"

NA = Nominal or no appreciable main of that diameter and type exists in PGLC system.

Cast iron pipe was manufactured to various standards over the approximately 100 years it was installed by PGL. While some pipe purchased prior to 1929 had even thicker walls than 1929 bell and spigot pipe (such as pipe purchased prior to 1900), the dimension standards, including wall thickness for 1929 bell and spigot pipe in 12 foot lengths is conservatively used as the typical standard for all pipe purchased prior to

1932 and is listed in the Table NO.2 below. Also listed is the 1952 standard wall thickness for cast iron mechanical joint pipe. While the date of transition to the thinner wall of the 1952 standard is not known, it is conservatively assumed that all cast iron pipe purchased after 1931 was made to the 1952 standard.

TABLE NO.2
DIMENSION STANDARDS FOR CAST IRON PIPE IN INCHES

	1929 BELL & SPIGOT PIPE(1)			1952 MECHANICAL JOINT PIPE(2)		
Nominal Diameter	Pipe O.D.	Pipe I.D.	Wall Thickness	Pipe O.D.	Pipe I.D.	Wall Thickness
4"	4.800	4.000	0.400	4.800	4.040	0.380
6"	6.900	6.040	0.430	6.900	6.080	0.410
8"	9.050	8.150	0.450	9.050	8.230	0.410
10"	11.100	10.120	0.490	11.100	10.220	0.440
12"	13.200	12.120	0.540	13.200	12.240	0.480
16"	17.400	16.160	0.620	17.400	16.400	0.500
20"	21.600	20.240	0.680	21.600	20.440	0.570
24"	25.800	24.280	0.760	25.800	24.540	0.630
30"	31.740	30.040	0.850	32.000	30.300	0.850
36"	37.960	36.060	0.950	38.300	36.560	0.870
48"	50.500	47.980	1.260	50.800	48.680	1.060
Also commonly found in PGL's pre-1929 pipe is:						
24"	25.500	24.00	0.75			

NOTES:

(1) Use the 1929 standard for original wall thickness of cast iron pipe installed prior to 1932.

(2) Use the 1952 standard for original wall thickness of cast iron pipe installed after 1931.

For ductile iron pipe standard dimensions are given in the Table No.3 below based on ASA Standard 21.50 dated May 10, 1965.

TABLE NO.3
DIMENSIONS STANDARDS FOR DUCTILE IRON PIPE IN INCHES (1)

NOMINAL DIAMETER	PIPE O.D.	PIPE I.D.	WALL THICKNESS
4"	4.80	4.29	0.29
6"	6.90	6.28	0.31
8"	9.05	8.39	0.33
10"	11.10	10.40	0.35
12"	13.20	12.46	0.37
16"	17.40	16.66	0.37
20"	21.60	20.82	0.39
24"	25.80	24.98	0.41
30"	32.00	31.06	0.47
36"	38.30	37.24	0.53
48"	50.80	49.50	0.65

NOTES:

(1) This standard is for pipe laid without blocking on un-tamped fill. It is based on a depth of cover of 5' and a working pressure of 250 PSIG, or more, for diameters up to 36" and to 200 PSIG for 48". It is also based on pipe minimum tensile yield strength of 60,000 PSI and minimum yield strength of 42,000 PSI. While PGL laid pipe on blocking, the standard above is believed typical of the pipe dimensions used for operating pressures of 25 PSIG or less, that were far below those pressures covered in the standard for pipe of these wall thicknesses.

According to ASA Standard 21.50, for ductile iron pipe a variation in manufacturing of pipe wall thickness of up to -.05" was acceptable in pipe up to 8" in diameter, a variation of up to -.06" for 12" diameter, and a variation of up to -.07" for 16" through 36" diameter pipe. For purpose of wall thickness loss computations, it is assumed all pipe met wall thickness specifications listed in Table No. 3 when manufactured.

Main Rank Index (MRI) points assigned on the basis of pipe coupons shall be determined by the wall thickness of the coupon relative to the minimum tolerable levels that are listed in Table No.1, and to the amount of pipe wall loss. For cast iron coupons, the original wall thickness will be based on Table No.2 data values. For cast iron pipe installed prior to 1932, the 1929 standard for original wall thickness shall be used from Table No.2 to compute pipe wall loss; and for pipe installed after 1931, the 1952 standard for original wall thickness shall be used from Table No.2 to compute pipe wall loss. For ductile iron pipe coupons, the original wall thickness shall be based on data values from Table No.3 to compute pipe wall loss.

Values for the pipe coupon **MRI** points are determined based on the following five conditions:

1. If the remaining pipe wall is greater than, or equal to, the value specified in Table No.1, plus 50% of the difference between the original value from Table No.2 for cast iron (or Table No.3 for ductile iron) less the appropriate value in Table No.1, then pipe coupon **MRI** points = zero (0) break equivalents.

2. If the remaining pipe wall is greater than, or equal to, the appropriate value specified in Table No.1, but by less than 50% of the difference between the original value given in Table No.2 for cast iron (or in Table No.3 for ductile iron), then pipe coupon **MRI** points = 0.2 break equivalents.

3. If the remaining pipe wall is less than the appropriate value specified in Table No.1, but greater than, or equal to, 75% of the Table No.1 value, then pipe coupon **MRI** points = 1.0 break equivalent.

4. If the remaining pipe wall is less than 75% of the appropriate value specified in Table No.1, but greater than, or equal to, 50% of the Table No.1 value, then pipe coupon **MRI** points = 2.0 break equivalents.

5. If the remaining pipe wall is less than 50% of the appropriate value specified in Table No.1, then pipe coupon **MRI** points = 4.0 break equivalents.

Two examples of application of the pipe coupon thickness point algorithm are:

1. A pre-1932 6" cast iron pipe coupon is found to have an average wall thickness of 0.100 inches. Table No.1 specifies a minimum wall thickness of 0.333" for 12' lengths of 6" pre- 1932 cast iron pipe. A 6" coupon of 0.100 inches is less than 50% of the specified Table No.1 value. Therefore, based on condition 5 above, assign a **MRI** of 4.0 break equivalents to the main segment based on coupon thickness.

2. A post-1931 6" cast iron pipe coupon is found to have an average thickness of 0.380 inches. This is greater, by an amount of 0.051", than the 0.329" minimum for 14' lengths specified in Table No.1 for 6" post-1931 cast iron pipe. Using the 1952 standard from Table No.2, the original pipe wall thickness was 0.41 inches, or 0.030" less than the original pipe wall thickness. As determined by condition 1 above, assign the pipe coupon **MRI** points equivalent to zero break equivalents.

Table NO.4 attached gives the break equivalents determined from the above equations for ranges of coupon thickness from the various diameters of cast and ductile iron main.

CAST AND DUCTILE IRON PIPE DEFICEINCY POINTS BASED ON BREAK EQUIVALENTSASSIGNEDTO PIPE COUPONS

NOMINAL DIAMETER	ORIGINAL WALL THICKNESS IN INCHES	MINIMUM THICKNESS	BREAK EQUIVALENTS ASSIGNED FOR REMAINING AVERAGE COUPON WALL THICKNESS									
			4 POINTS WALLTHICKNESS		2 POINTS WALLTHICKNESS		1 POINTS WALL THICKNESS		0.2 POINTS WALL THICKNESS		OPQINTS WALL THICKNESS	
			FROM	TO	FROM	TO	FROM	TO	FROM	TO	FROM	TO
FOR CAST IRON PIPE INSTALLED PRIOR TO 1932 IN 12' LENGTHS (11' span between blocking)												
4	0.400	0.340	0.000	0.169	0.170	0.254	0.255	0.338	0.339	0.369	0.370	>.370
6	0.430	0.333	0:000	0.166	0.167	0.249	0.250	0.321	0.332	0.381	0.382	>.382
6	0.450	0.240	0.000	0.119	0.120	0.179	0.180	0.238	0239	0.344	0.345	>.345
10	0.490	0.191	0.000	0.095	0.096	0.142	0.143	0.189	0.190	0.340	0.341	>.341
12	0.54(1	0.217	0.000	0.108	0.109	0.162	0.163	0.215	0.216	0.378	0.379	>.379
16	0.620	0286	0.000	0.142	0.143	0214	0215	0284	0285	0.452	0.453	>.453
20	0.680	0.355	0.000	0.177	0.178	0.265	0.266	0.353	0.354	0.517	0.516	>.518
24	0.760	0.422	0.000	0.210	0.211	0.316	0.317	0.420	0.421	0.590	0.591	>.592
30	0.850	0.520	0.000	0259	0.260	0.389	0.390	0.516	0.519	0.684	0.665	>.685
36	0.950	0.623	0.000	0.311	0.312	0.467	0.468	0.621	0.622	0.786	0.787	>.788
48	1260	0.827	0.000	0.413	0.414	0.619	0.620	0.825	0.826	1.043	1.044	>1.045
FOR CAST IRON PIPE INSTALLED AFTER 1931 IN 16' LENGTHS (14' span between blocking)												
4	0.380	NA	0.000	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	0.410	0.329	0.000	0.164	0.165	0.246	0.247	0.327	0.328	0.369	0.370	>.370
8	0.410	0.237	0.000	0.116	0.119	0.177	0.178	0.235	0.236	0.323	0.324	>.324
10	0.440	0.189	0.000	0.094	0.095	0.141	0.142	0.187	0.188	0.314	0.315	>.315
12	0.480	0.191	0.000	0.094	0.095	0.142	0.143	0.189	0.190	0.334	0.335	>.335
16	0.500	0.251	0.000	0.125	0.128	0.187	0.188	0.249	0250	0.375	0.376	>.376
20	0.570	0.312	0.000	0.155	0.156	0.233	0.234	0.310	0.311	0.440	0.441	>.441
24	0.630	0.372	0.000	0.185	0.186	0.278	0279	0.371	0.372	0.500	0.501	>.501
30	0.850	0.458	0.000	0.228	0.229	0.343	0.344	0.456	0.457	0.653	0.654	>.654
36	0.870	0.548	0.000	0273	0.274	0.410	0.411	0.546	0.547	0.708	0.709	>.704
48	1.060	0.727	0.000	0.363	0.364	0.544	0.545	0.725	0.726	0.894	0.895	>.895
FOR DUCTILE IRON PIPE INSTALLED IN 16' LENGTHS (14' span between blocking)												
4	0290	NA	0.000	NA	NA	NA	NA	NA	NA	NA	NA	NA
6	0.310	0.089	0.000	0.044	0.045	0.068	0.067	0.068	0.089	0.199	0.200	>.200
8	0.330	0.075	0.000	0.037	0.038	0.055	0.056	0.073	0.074	0.202	0.203	>.203
10	0.350	NA	0.000	NA	NA	NA	NA	NA	NA	NA	NA	NA
12	0.370	0.110	0.000	0.054	0.055	0.082	0.083	0.108	0.109	0239	0.240	>.240
16	0.370	0.145	0.000	0.072	0.073	0.108	0.109	0.143	0.144	0.257	0.258	>.258
20	0.390	0.180	0.000	0.089	0.090	0.134	0.135	0.178	0.179	0.284	0285	>285
24	0.410	0.214	0.000	0.106	0.107	0.160	0.161	0.212	0.213	0.311	0.312	>.312
30	0.470	0.263	0.000	0.131	0.132	0.196	0.197	0.261	0.262	0.366	0.367	>.367
36	0.530	0.315	0.000	0.157	0.158	0.235	0236	0.313	0.314	0.422	0.423	>.423
48	0.650	0.418	0.000	0.208	0.209	0.313	0.314	0.416	0.417	0.533	0.534	>.534

APPENDIX B

GRAPHS TO DETERMINE FORECAST DATES FOR REPLACEMENT

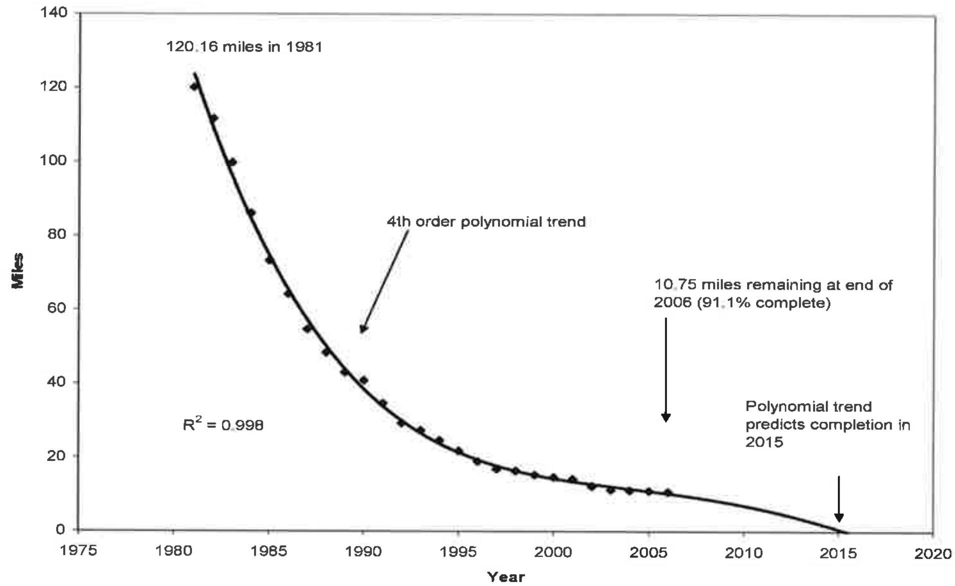

Figure B-1. Forecast to Completion for 4-inch Pipe

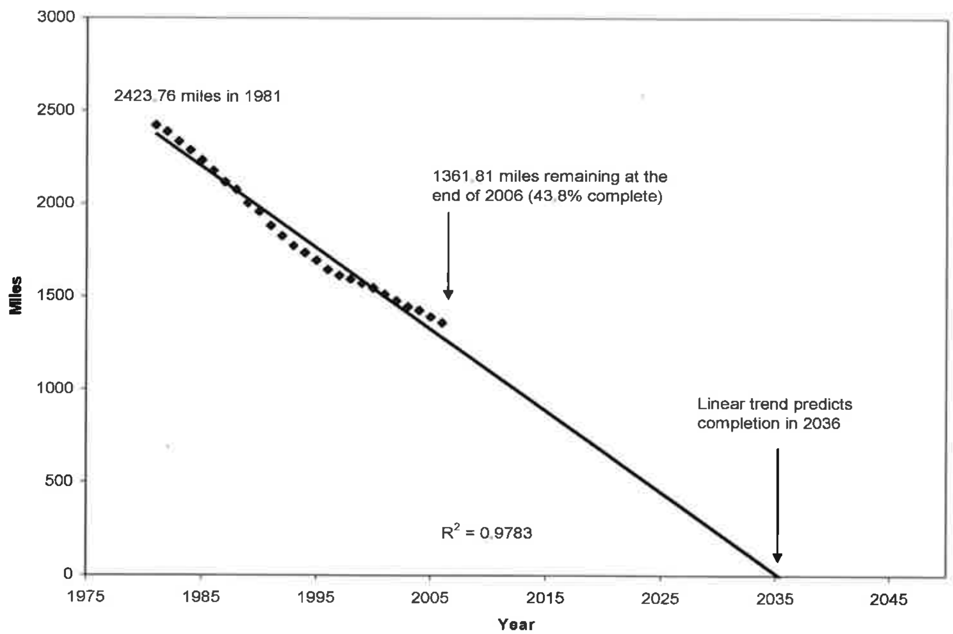

Figure B-2. Forecast to Completion for 6-inch Pipe

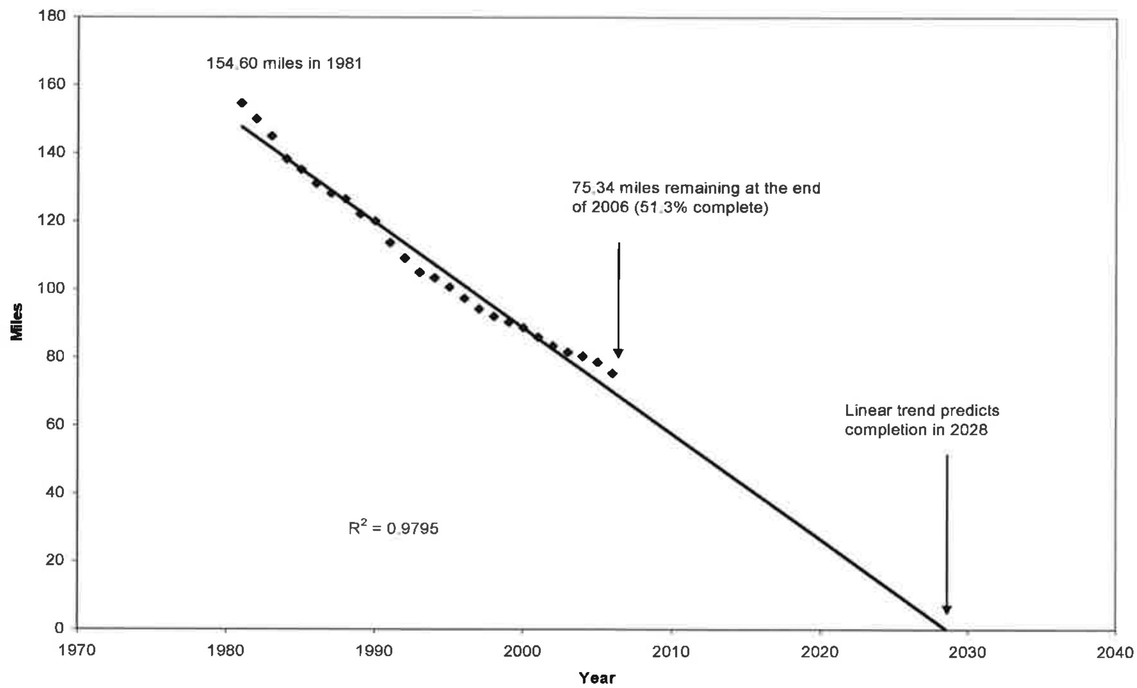

Figure B-3. Forecast to Completion for 8-inch Pipe

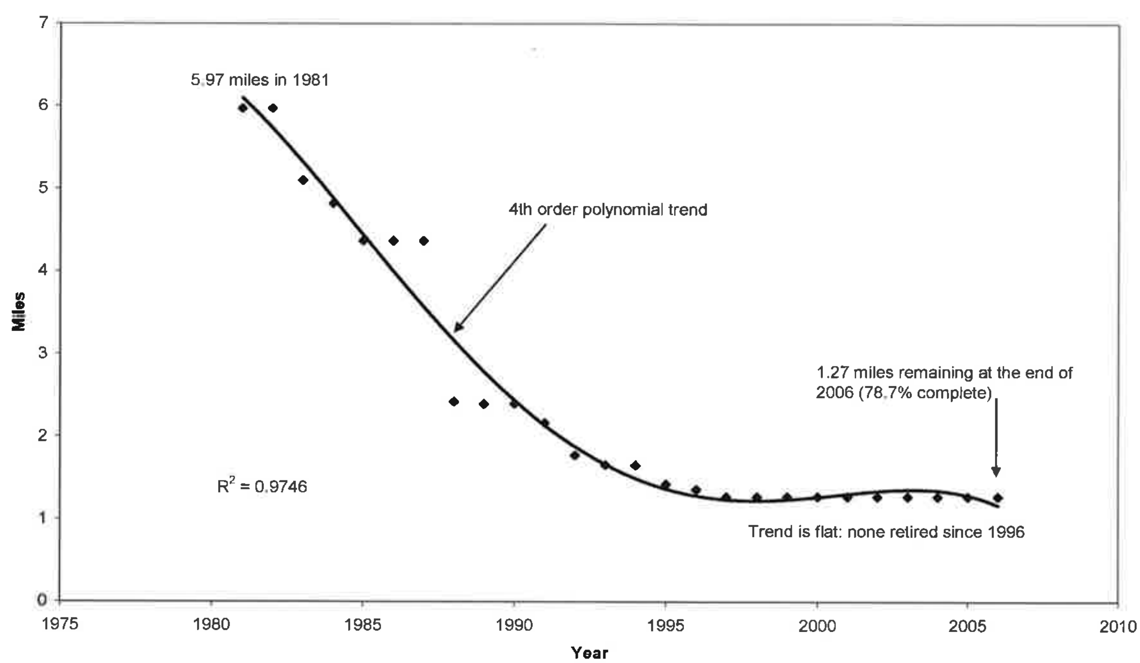

Figure B-4. Forecast to Completion for 10-inch Pipe

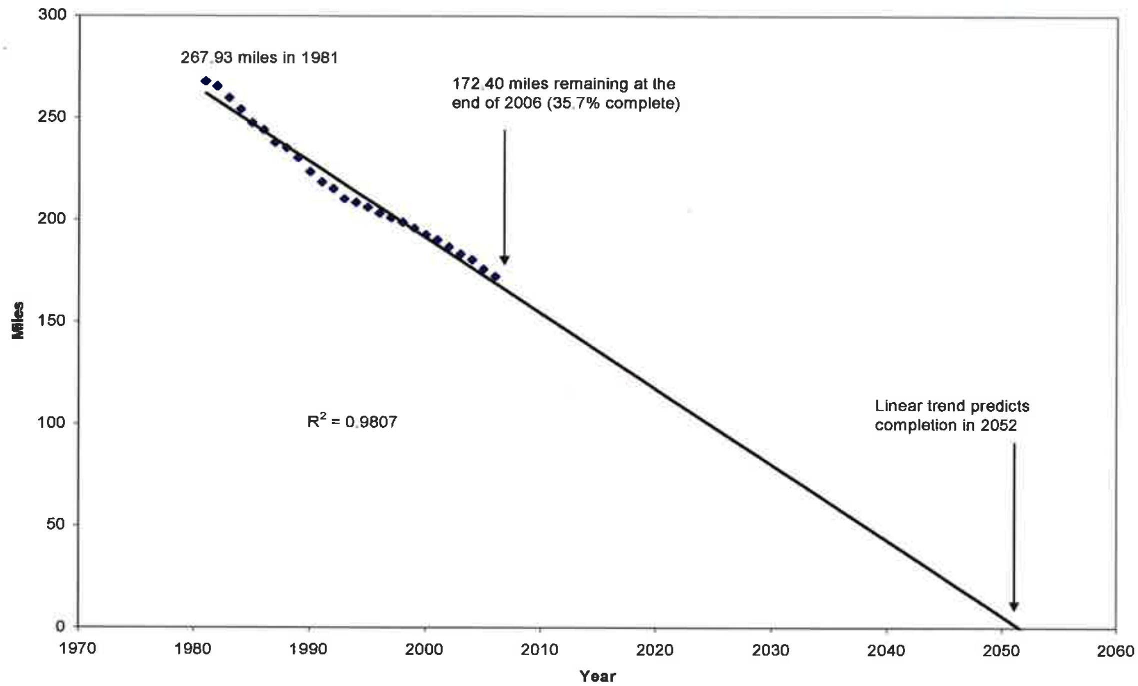

Figure B-5. Forecast to Completion for 12-inch Pipe

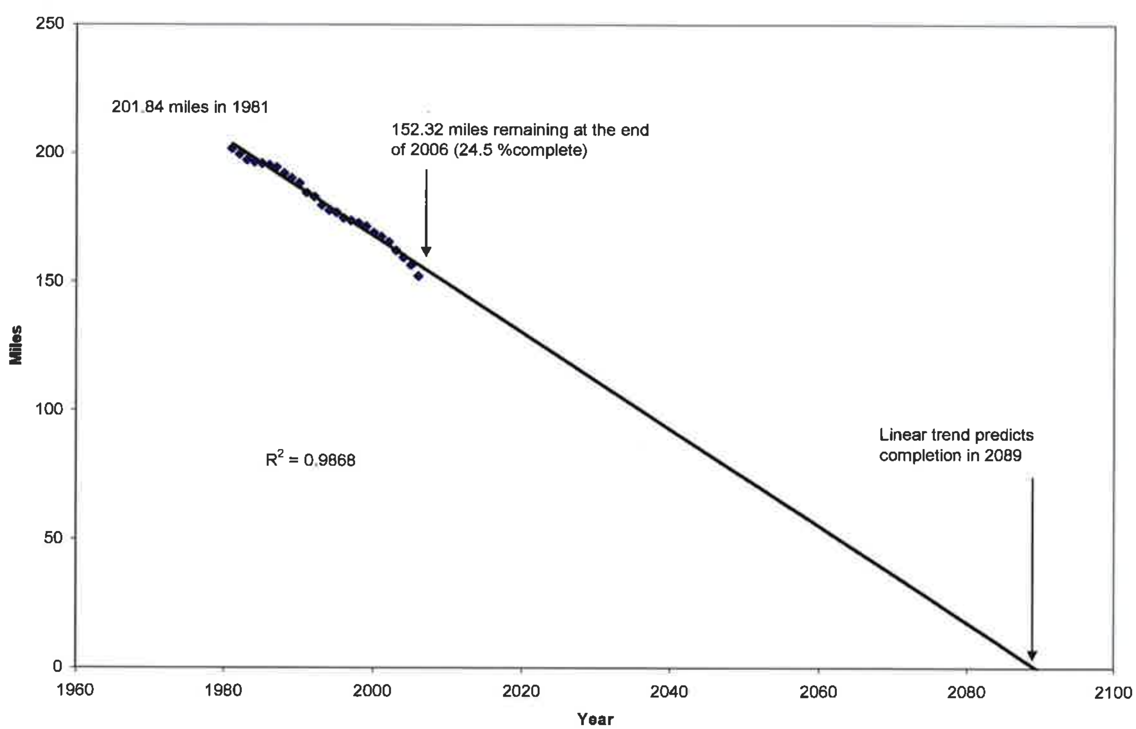

Figure B-6. Forecast to Completion for 16-inch Pipe

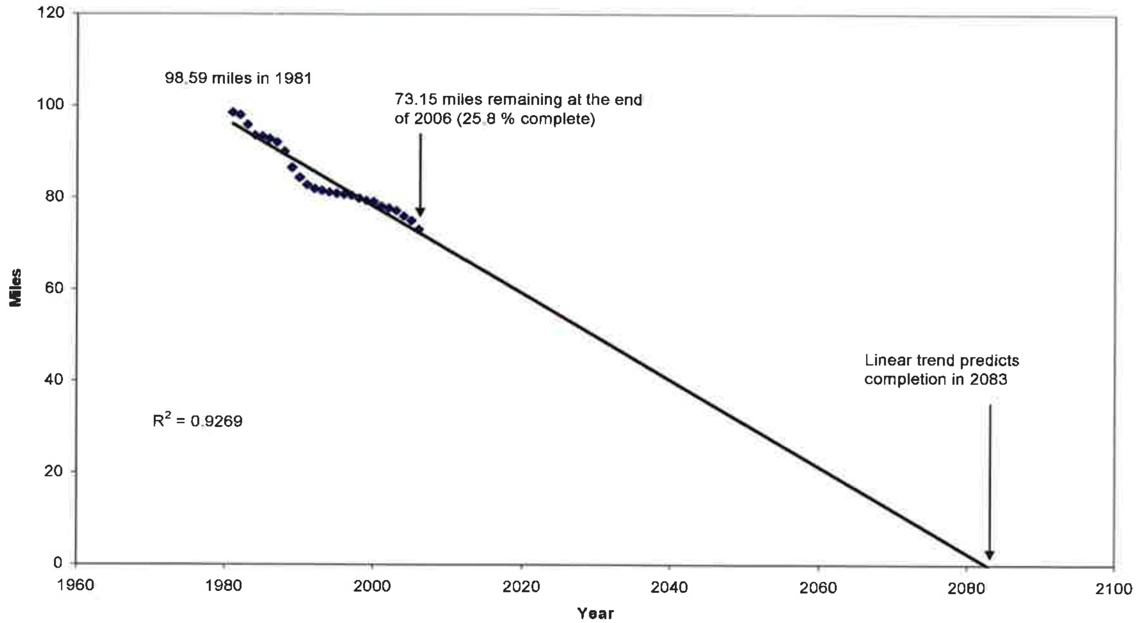

Figure B-7. Forecast to Completion for 20-inch Pipe

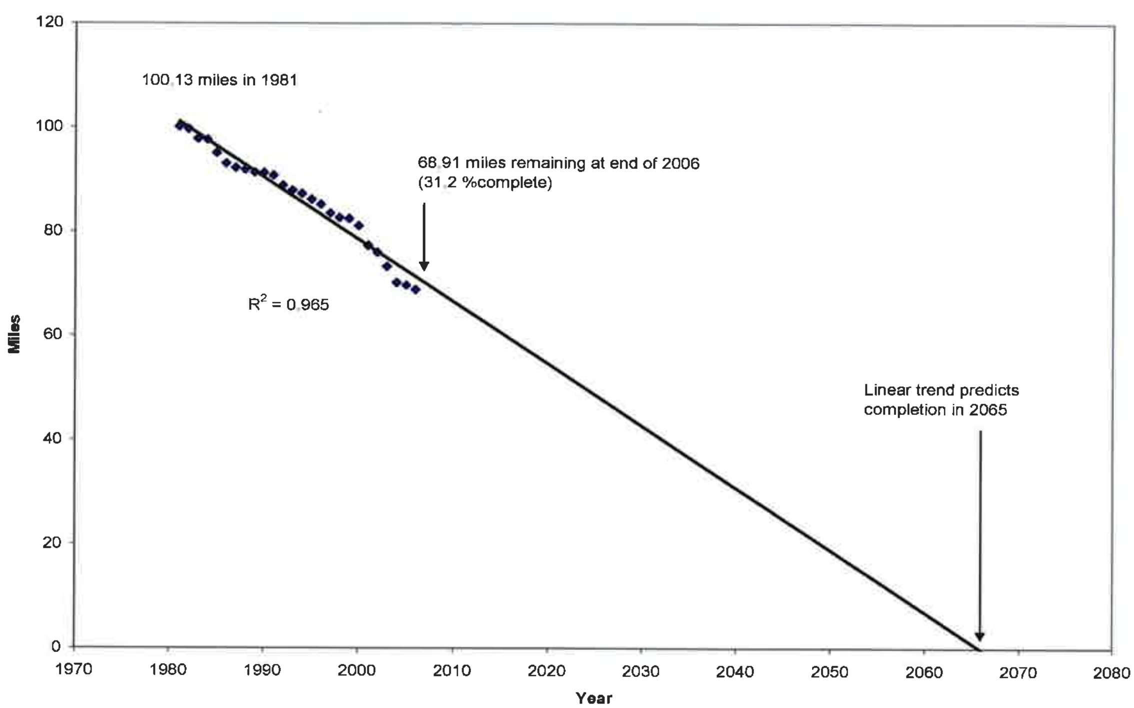

Figure B-8. Forecast to Completion for 24-inch Pipe

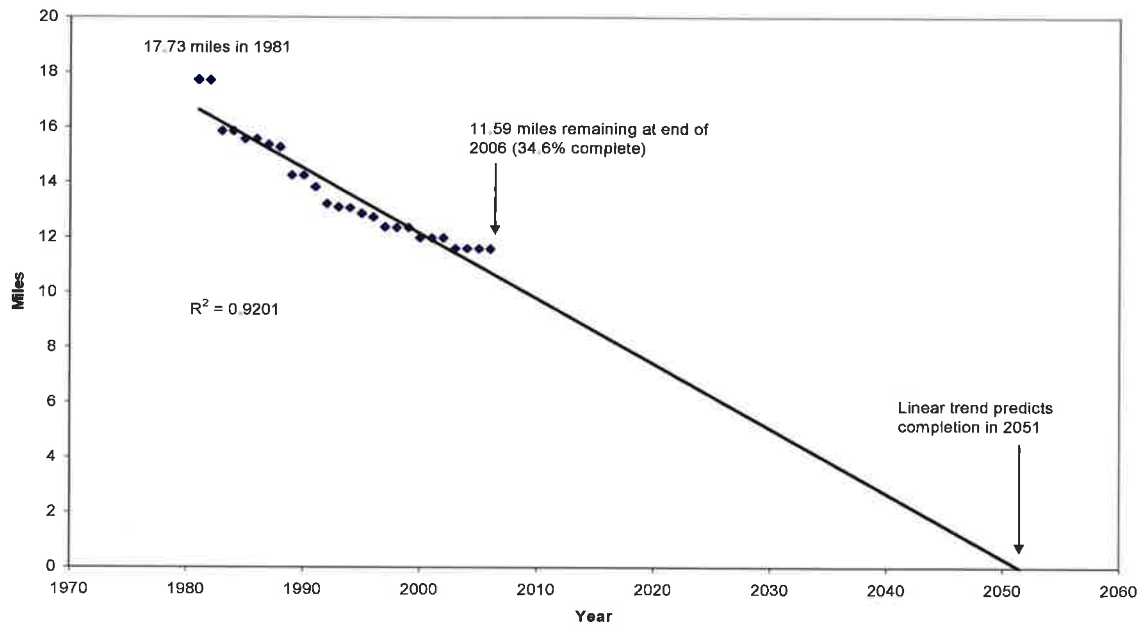

Figure B-9. Forecast to Completion for 30-inch Pipe

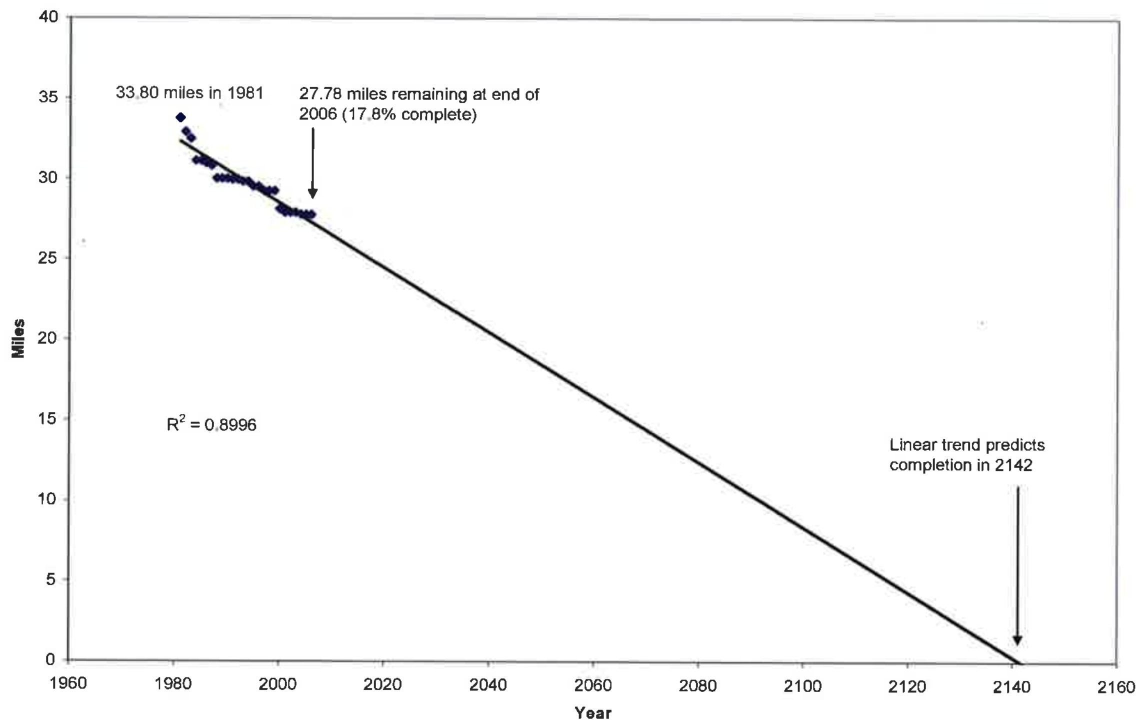

Figure B-10. Forecast to Completion for 36-inch Pipe

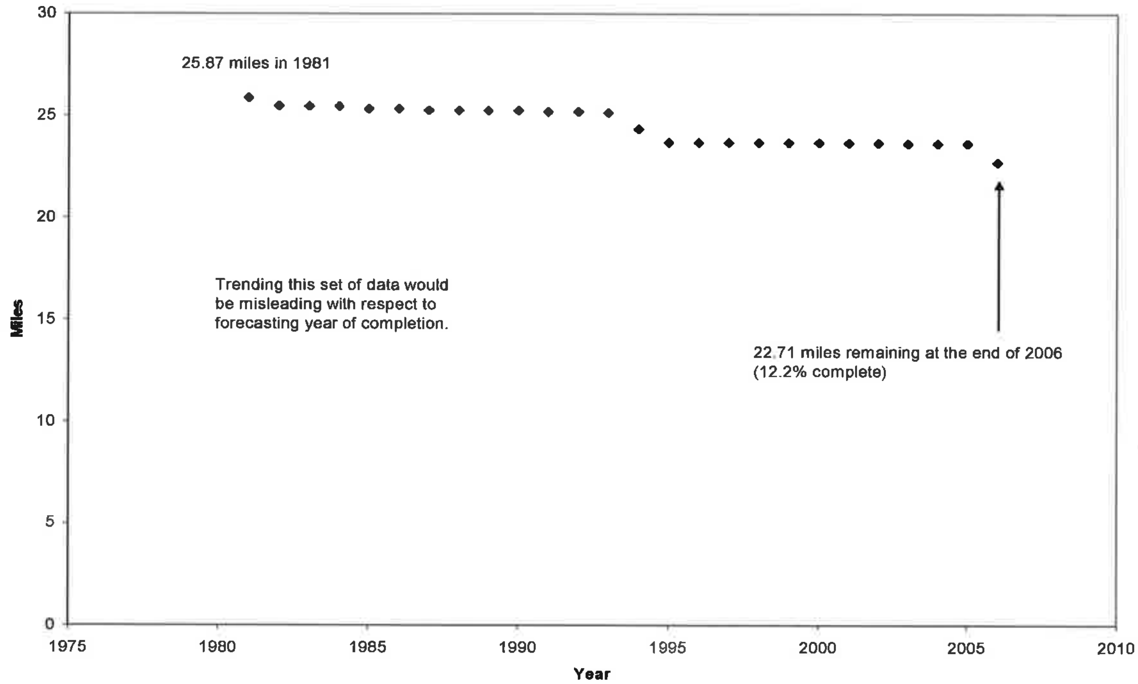

Figure B-11. Forecast to Completion for 48-inch Pipe

APPENDIX C
BASIS FOR COST ANALYSIS OF THE THREE REPLACEMENT SCENARIOS

The cost data for the three scenarios considered in this report were developed based on actual cost data provided by PGL.

These data show how much PGL is actually spending replacing CI and DI mains. Our objective was to calculate a reasonable estimate for the cost per foot to continue replacements going forward under three different scenarios. Because the main focus was to compare the relative costs of the scenarios, we made certain assumptions that seemed reasonable to project forward. All cost projections are in 2006 dollars and are not adjusted for inflation, since this is a relative comparison. The time value of money has not been estimated and must be left for PGL to determine based on their own internal criteria. The reality check for the assumptions is that using them we were able to calculate an estimate of the 2006 costs that agreed within 0.5 percent with the actual costs.

First we grouped the pipes by size into the following categories.

- 4-inch through 8-inch mains
- 10-inch through 20-inch mains
- 24-inch through 48-inch mains

We assumed that 85% of the costs of replacing services and meters associated with the replacements would be associated with the first group, namely the 4-inch through 8-inch mains and that 15% of the costs of replacing services and meters associated with the replacements would be associated with the second group, namely the 10-inch through 20-inch mains. We assumed that the costs for service and meter replacements associated with mains 24-inch and larger, the third group, would be zero.

The total cost per mile for replacement for any pipe size within one of the three groups is the sum of three costs: 1) the cost of main replacement per mile, 2) the cost of replacing the services associated with pipe sizes within the group, and 3) the cost of replacing the meters associated with pipe sizes within the group. The costs of main replacement were calculated by dividing the total cost per mile for the group by the total miles of pipe replaced in that size group. This came to a main replacement cost per mile of $272,037.

The average estimated number of service replacements per mile associated with Group 1 was 85 percent of 150.90 services per mile or 128.265 services per mile. At a cost of $1000 per service, the service replacements associated with Group 1 mains cost $128,265.00 per mile.

The average estimated number of meter replacements per mile associated with Group 1 was 85 percent of 202.34 meters per mile or 171.989 meters per mile. At a cost of $736.40 per meter, the meter replacements associated with Group 1 mains cost $126,652.70 per mile.

The total replacement cost per mile for Group 1 mains is $272,037+128,265+126,652=$526,944.

By a similar process the cost for Group 2 replacements were determined to be $1,006,315 per mile, and the cost for Group 3 replacements were determined to be $2,081,482.

The reality check on our assumptions was provided by using the process for calculating 2006 replacement costs.

Table C-1. Actual Miles Retired and Cost

Pipe Size, inches	Miles Retired in 2006
4	0.31
6	31.45
8	3.25
10	0.00
12	3.84
16	4.33
20	1.94
24	0.97
30	0.01
36	0.00
48	0.93
TOTAL	**47.01**
Capital Cost	**$32,552,395**

Using the process we developed above, one gets the following.

Table C-2. Total Costs for 2006

Pipe Size, inches	Miles Replaced in 2006	Total Miles Group 1	Total Miles Group 2	Total Miles Group 3	Cost per Mile by Group, dollars	Cost by Group, dollars
4	0.31					
6	31.45					
8	3.25	35.00			526,944	18,444,537
10	0.00					
12	3.84					
16	4.33					
20	1.94		10.10		1,006,315	10,166,259
24	0.97					
30	0.01					
36	0.00					
48	0.93			1.90	2,081,482	3,957,576
					Total	**32,568,372**

Our calculated number is very close to the actual number.

APPENDIX D
DATA REVIEWED FOR THE STUDY

D-1

Data items reviewed for the study:

Zinder Engineering, Inc., "Cast Iron Pipe Replacement Study for Peoples Gas Light and Coke Company" Volume I. Engineering Report No. ER-048, May 22, 1981.

Zinder Engineering, Inc., "Supplement No. 1 to Engineering Report No. ER-048" Volume I. February 3, 1994.

Zinder Engineering, Inc., "Supplement No. 2 to Engineering Report No. ER-048" Volume I. June 3, 2002.

Zinder Engineering, Inc., "Supplement No. 2 to Engineering Report No. ER-048" Volume II. June 3, 2002.

The following are database files containing information on all the active and retired segments in the system. The information contained in these files includes all the maintenance history, the MRI scores, and segment attribute data from 1981 through 2006.

KIEMOD1.DBF
KIEMOD1R.DBF
KIEMOD7.DBF
KIEMOD7R.DBF
ALLMOD1.DBF
GMACT1.DBF
GMACT2.DBF
GMRETIRE.DBF

The following spreadsheets contain historic replacement and retirement costs used to develop cost estimates on a going forward basis.

CI-DI Replacement 1-30-07.xls
2007 conversioncosts.xls

REQUEST NO. AG 11.18:

Please refer to Company's DIMP/SHRIMP ("Simple, Handy, Risk-based Integrity Management Plan") and respond to the following:

a. For 2010 to the present, please identify which years the Company's distribution system was not safe and reliable, and provide supporting references for this conclusion from the DIMP/SHRIMP.
b. For 2010 to the present, please identify which years the Company's system presented an unmanageable level of leaks, and provide supporting references for this conclusion from the DIMP/SHRIMP.

RESPONSE:

The Distribution Integrity Management Program (DIMP) is a tool to identify threats to the distribution system. The threats that are identified are ranked by the relative amount of risk that it poses to the distribution system.

a. For 2010 to present, the distribution system was never deemed unsafe or unreliable. This does not mean that threats and risks do not exist.
b. For 2010 to present there has not been an unmanageable level of leaks. This does not mean that threats and risks do not exist.

Person(s) Responsible:

Thomas Webb -- Manager, Compliance

The Peoples Gas Light and Coke Company
Docket No. 16-0376
Response to the Illinois Attorney General's 6th Set of Data Requests
Date of Requests: September 2, 2016

REQUEST NO. AG 6.06:

Please describe in detail the extent to which PGL has entered into contracts with vendors for System Modernization Program work during 2017 and future years. Please describe in detail PGL's rights or obligations in connection with potentially curtailing or terminating each of these contracts.

RESPONSE:

Peoples Gas has current Purchase Orders with construction contractors for work that has begun or will begin in 2016 and will continue into 2017. Future work with each contractor will be based on Requests for Proposals that will be issued at future dates. See **AG 6.06 Attach 01** for a list of the expected 2017 carryover projects.

Peoples Gas enters Master Services Agreement (MSAs) with contractors are typical across different contractors with case-specific amendments or exceptions.

Attached is Section 9 of the MSA that contains provisions for termination. See **AG 6.06 Attach 02.**

Person(s) Responsible:

Virginia Alioto -- Director of Contracting

SUPPLEMENTAL RESPONSE:

In response to Assistant Attorney General Sameer Doshi's September 30, 2016 email, please refer to **AG 6.06 Attach 03**, which contains Schedule 4.1 to the MSA.

Person(s) Responsible:

Virginia Alioto -- Director of Contracting

2017 CARRYOVER PROJECTS

Project ID	ProjectName / Description	Phase	BCA	[redacted]	Shop	ProjectStatus
C-14-02	South Austin	31	1879	[redacted]	Central	Preconstruction
C-14-02	South Austin	32	1881	[redacted]	Central	Preconstruction
C-14-02	South Austin	33	1886	[redacted]	Central	Preconstruction
C-14-02	South Austin	34	1885	[redacted]	Central	Preconstruction
C-14-02	South Austin	35	1883	[redacted]	Central	Preconstruction
C-14-02	South Austin	36	1884	[redacted]	Central	Preconstruction
N-13-01	Portage Park	11	912	[redacted]	North	Preconstruction
N-13-01	Portage Park	12	913	[redacted]	North	Preconstruction
N-13-01	Portage Park	17	918	[redacted]	North	Preconstruction
S-13-01	South Shore	1A	1117	[redacted]	South	Preconstruction
S-13-01	South Shore	3	1007	[redacted]	South	Preconstruction
S-SSHO-12-MR-CR01513	South Shore (79th & Exchange RR Crossing)	12	1513	[redacted]	South	Preconstruction
S-SSHO-18-MR-CR01511	South Shore (73rd & Exchange RR Crossing)	18	1511	[redacted]	South	Preconstruction
S-SSHO-24-MR-CR01508	South Shore (71st & Stony RR Crossing)	24	1508	[redacted]	South	Preconstruction
S-15-03	Beverly	14	1446	[redacted]	South	Preconstruction
S-15-03	Beverly	15	1452	[redacted]	South	Preconstruction
S-15-03	Beverly	16	1450	[redacted]	South	Preconstruction
S-15-03	Beverly	18	1458	[redacted]	South	Preconstruction
S-15-03	Beverly	19	1460	[redacted]	South	Preconstruction
S-15-03	Beverly	20	1456	[redacted]	South	Preconstruction
S-15-03	Beverly	21	1457	[redacted]	South	Preconstruction
S-15-03	Beverly	22	1455	[redacted]	South	Preconstruction
S-15-03	Beverly	23	1447	[redacted]	South	Preconstruction
S-CO-1241	Pershing & Iron	N/A	1241	[redacted]	South	Preconstruction
C-0000-01-CO-CN01242	31st Pl & S Wood St	N/A	1242	[redacted]	Central	Preconstruction
C-SE-2159	375 N Morgan	N/A	2159	[redacted]	Central	Preconstruction
N-0000-01-HP-CR02633	Major & Dakin HP-MP Vault / HP Main	N/A	2633	[redacted]	North	Preconstruction
N-0000-01-HP-CR03043	Major & Dakin Vault(s) MP Main	N/A	3043	[redacted]	North	Preconstruction
N-0000-01-SI-CR02792	514-528 W Barry	N/A	2792	[redacted]	North	Preconstruction
C-0000-01-SE-CN02651	311 N Morgan	N/A	2651	[redacted]	Central	Preconstruction
N-0000-01-TI-CN03119	North & Magnolia - Tunnel Remediation	N/A	3119	[redacted]	North	Preconstruction
S-0000-01-SI-CR03088	81st & Wabash UMRI	N/A	3088	[redacted]	South	Preconstruction
N-0000-01-SE-CN02013	O'Hare Car Rental	N/A	2013	[redacted]	North	Preconstruction
C-0000-01-SI-CR02696	IDOT Flyover South UIC - Part 2	2	2696	[redacted]	Central	Preconstruction
N-0000-01-SI-CR02795	751-781 W Melrose St - Branch Feeder Replace	N/A	2795	[redacted]	North	Preconstruction
S-0000-01-SE-CN03133	508 W. 51st St	N/A	3133	[redacted]	South	Preconstruction
S-0000-01-PI-CR03122	76th & Blackstone Sewer	N/A	3122	[redacted]	South	Preconstruction
C-0000-01-SE-CN02652	9 W. Walton St	N/A	2652	[redacted]	Central	Preconstruction
S-0000-01-SI-CR03246	80th & Emerald - Poor Supply Phase 2	2	3246	[redacted]	South	Preconstruction
S-0000-01-SI-CN01316	103rd & State Vault (57)	N/A	1316	[redacted]	South	Preconstruction
C-0000-01-SI-CR03274	Warren, Tallman to Western Poor Supply	N/A	3274	[redacted]	Central	Preconstruction
C-0000-01-PI-CN03279	54th & Kedzie Sewer (Non-QIP)	N/A	3279	[redacted]	Central	Preconstruction
C-0000-01-SI-CR03228	52nd & Newland UMRI - Poor Supply	N/A	3228	[redacted]	Central	Preconstruction
C-0000-01-SC-CN03333	3817 W Fillmore Retirement	N/A	3333	[redacted]	Central	Preconstruction
S-0000-01-SC-CN03335	99th and Oglesby Sewer Reroute	N/A	3335	[redacted]	South	Preconstruction
S-0000-01-SE-CN03217	9130 S. Vincennes Ave	N/A	3217	[redacted]	South	Preconstruction
C-0000-01-SI-CR03288	5500 S Nagle Poor Supply	N/A	3288	[redacted]	Central	Preconstruction
C-0000-01-SC-CR03261	220 S Ashland Retirement	N/A	3261	[redacted]	Central	Preconstruction
S-0000-01-SE-CN03275	4001 E 98th St	N/A	3275	[redacted]	South	Preconstruction
S-0000-01-PI-CR03109	72nd & Green Sewer	N/A	3109	[redacted]	South	Preconstruction
S-0000-01-PI-CN02551	61st & St. Lawrence Bridge Support	N/A	2551	[redacted]	South	Preconstruction
N-NWI5-01-HP-CR03312	WI Ph5A LP-MP; Avondale and Hurlbut LPMP Part	5A	3312	[redacted]	North	Preconstruction
N-NWI5-02-HP-CR02242	NWI Ph5A LP-MP; Octavia & Onarga LPMP	5A	2242	[redacted]	North	Preconstruction
N-NWI5-03-HP-CR02874	Ph5A HP; Muligan/Bryn Mawr to Avondal/Thornd	5A	2874	[redacted]	North	Preconstruction
N-NWI5-04-HP-CR03208	WI Ph5A HP; Avondale, Thorndale to Nickerson H	5A	3208	[redacted]	North	Preconstruction
N-NWI5-05-HP-CR03209	NWI Ph5A HP; Avondale & Nina HP Jack-and-Bore	5A	3209	[redacted]	North	Preconstruction
N-NWI5-06-HP-CR03210	Ph5A HP; Avondale, Nickerson to Northwest Hw	5A	3210	[redacted]	North	Preconstruction
N-NWI5-07-HP-CR03211	Ph5A HP; Northwest Hwy/Sayre to Octavia/Onarg	5A	3211	[redacted]	North	Preconstruction
N-NWI5-08-HP-CR03212	NWI Ph5A HP; Highland & Neva HP	5A	3212	[redacted]	North	Preconstruction
N-NWI5-09-HP-CR03213	NWI Ph5A HP; Highland & Neva ROV Cluster	5A	3213	[redacted]	North	Preconstruction
N-NWI5-10-HP-CR03214	NWI Ph5A HP; Highland & Neva HP-MP Vault	5A	3214	[redacted]	North	Preconstruction
N-NWI5-11-HP-CR03065	NWI Ph5A HP; Highland & Neva STMP Main	5A	3065	[redacted]	North	Preconstruction
N-NWI5-12-HP-CR02659	NWI Ph5A HP; Highland & Neva SCADA	5A	2659	[redacted]	North	Preconstruction
N-NWI5-13-HP-CR03215	VI Ph5A HP; Odell/Octavia, North Shore to Touhy	5A	3215	[redacted]	North	Preconstruction
N-NWI5-14-HP-CR03064	NWI Ph5A HP; Avondale & Nagle HP-MP Vault	5A	3064	[redacted]	North	Preconstruction

2017 CARRYOVER PROJECTS

Project ID	ProjectName / Description	Phase	BCA	[redacted]	Shop	ProjectStatus
N-NWI5-15-HP-CR02658	NWI Ph5A HP; Avondale & Nagle SCADA	5A	2658	[redacted]	North	Preconstruction
N-NWI5-16-HP-CR03066	NWI Ph5A HP; Touhy & Odell HP-MP Vault	5A	3066	[redacted]	North	Preconstruction
N-NWI5-17-HP-CR02660	NWI Ph5A HP; Touhy & Odell SCADA	5A	2660	[redacted]	North	Preconstruction
S-0000-01-CL-CN02607	108th - 112th & Torrence	N/A	2607	[redacted]	South	Preconstruction
TI-02	nnedy ExWy (Belmont) & Albany Tunnel Remedia	N/A	TI02	[redacted]	North	Preconstruction
S-0000-01-PI-CN02596	Davol & Monterey Sewer Bridge Support	N/A	2596	[redacted]	South	Preconstruction
C-0000-01-PI-CN03023	Springfield & 78th Sewer	N/A	3023	[redacted]	Central	Preconstruction
N-0000-01-SE-CN03353	540 W. Webster Ave Service	N/A	3353	[redacted]	North	Preconstruction
N-0000-01-SI-CR03369	540 W. Webster Ave Retirement	N/A	3369	[redacted]	North	Preconstruction
C-0000-01-PI-CN03259	Fulton & Carpenter Street Scape	N/A	3259	[redacted]	Central	Preconstruction
N-0000-01-SE-CN03286	3587 N. Clark St New Service Request	N/A	3286	[redacted]	North	Preconstruction
C-0000-01-SC-CR03374	5029 S Fairfield Leak Grade 2	N/A	3374	[redacted]	Central	Preconstruction
C-0000-01-SC-CR03375	5137 S Sawyer Leak Grade 2	N/A	3375	[redacted]	Central	Preconstruction
S-0000-01-SC-CR03378	9211 S Essex Leak Grade 2	N/A	3378	[redacted]	South	Preconstruction
S-0000-01-SC-CR03383	6107 S Ellis Leak Grade 2	N/A	3383	[redacted]	South	Preconstruction
S-0000-01-SC-CR03379	616 E 103rd PL Leak Grade 2	N/A	3379	[redacted]	South	Preconstruction
N-0000-01-SC-CR03380	5619 N Mozart Leak Grade 2	N/A	3380	[redacted]	North	Preconstruction
S-0000-01-SC-CR03376	99441 S Calumet Leak Grade 2	N/A	3376	[redacted]	South	Preconstruction
N-0000-01-SE-CN03347	349-7359 W. North Shore Ave New Service Reque	N/A	3347	[redacted]	North	Preconstruction
C-0000-01-SC-CN03394	45th and La Crosse Retirement	N/A	3394	[redacted]	Central	Preconstruction
S-0000-01-PI-CR03439	Emerald & 78th Sewer	N/A	3439	[redacted]	South	Preconstruction

ARTICLE 9 – TERM, TERMINATION AND REMEDIES

9.1 Term. This Agreement shall be effective as of the Effective Date and shall continue in effect until December 31, 2016 (the "***Initial Term***"), unless earlier terminated as provided herein. At the end of the Initial Term, Company shall have the right upon written notice to Contractor to renew the Agreement (each such period, an "***Extended Term***"). As used herein, "***Term*"** means the Initial Term, any Extended Terms and any Termination Assistance Period that extends beyond the length of the Initial Term or any Extended Term.

9.2 Termination for Cause by Company. Company shall have the right to terminate the Agreement, in whole or in part, if:

(a) Contractor fails to: (i) achieve the MSL for any single Critical Measure for any two (2) or more consecutive Measurement Windows; (ii) achieve the MSL for any single Critical Measure for three (3) or more Measurement Windows in any rolling period comprised of five (5) Measurement Windows; (iii) achieve the MSL for any single Key Performance Indicator for any three (3) or more consecutive Measurement Windows; (iv) achieve the MSL for any single Key Performance Indicator for four (4) or more Measurement Windows in any rolling period comprised of six (6) Measurement Windows; (v) achieve the MSL for any three (3) or more Critical Measures in a given Measurement Window; and/or (vi) achieve the MSL for any five (5) or more Key Performance Indicators in a given Measurement Window, any of which failure(s) shall not be subject to a cure period;

(b) Contractor fails to correct any Control Deficiencies identified in a Corrective Plan pursuant to **Section 5.4.3**, unless such failure is cured by Contractor within fourteen (14) days following its receipt of written notice from Company;

(c) Contractor fails to comply in any material respect with the provisions of **Article 3** regarding Contractor Key Personnel, unless such failure is cured by Contractor within ten (10) days following its receipt of written notice from Company;

(d) Contractor fails to comply with its obligations under **Section 12.1(d)**, unless such failure is cured by Contractor within fourteen (14) days following its receipt of written notice from Company; or

(e) Contractor materially breaches any of its other (meaning those not enumerated in **subsections (a)** through **(d)** above) obligations under the Agreement, unless such material breach is cured by Contractor within thirty (30) days following its receipt of written notice from Company. Contractor acknowledges that a material breach may be comprised of a series of breaches that individually are not material but become material in the aggregate because of proximity in time, because they result from a common cause or because of other circumstances.

9.3 Termination for Cause by Contractor. In the event that Company fails to pay material, undisputed amounts when due under the Agreement, Contractor shall promptly provide Company with written notice specifying the alleged material breach. Company shall have thirty (30) days within which to cure such breach or propose a reasonable plan to cure such breach. In the event of Company's failure within such thirty (30) day period to cure such breach or to propose a reasonable plan for the cure thereof, Contractor may terminate the Agreement upon written notice to Company.

9.4 Termination for Insolvency, Change of Control or Force Majeure Events.

9.4.1 Insolvency. In addition to Company's rights under **Section 15.6**, Company shall have the right to terminate the Agreement on ten (10) days written notice to Contractor if Contractor becomes or is declared insolvent, becomes subject to a voluntary or involuntary bankruptcy or similar proceeding, or makes an assignment for the benefit of all or substantially all of its creditors.

9.4.2 Change of Control. For its convenience, Company shall have the right on ten (10) days written notice to Contractor to terminate the Agreement if Contractor experiences a Change of Control.

9.4.3 Force Majeure Events. If a Force Majeure Event substantially prevents, hinders or delays Contractor's performance of material Work for five (5) consecutive days or more, or for seven (7) consecutive or non-consecutive days or more during any ten (10) day period, thereby causing an adverse impact on the business operations of Company and/or its Affiliates, then Company shall have the right to terminate the Agreement and/or affected Work specified by Company upon written notice to Contractor.

9.5 Termination for Convenience. Company shall have the right on sixty (60) days written notice to Contractor to terminate the Agreement for its convenience or at any time to terminate a Purchase Order for its convenience. If the Agreement or a Purchase Order is terminated pursuant to this **Section 9.5**, Company shall pay to Contractor an amount determined in accordance with the terms set forth in **Schedule 4.1**, which amount shall be calculated as of the date on which Contractor completes to Company's reasonable satisfaction all Termination Assistance Work requested by Company (the "***Termination for Convenience Fee***") as follows: fifty percent (50%) upon expiration of the sixty (60) day notice period, and fifty percent (50%) following Contractor's completion to Company's reasonable satisfaction all Termination Assistance Work requested by Company. Except as expressly set forth in this **Section 9.5**, there shall be no Termination for Convenience Fees payable in connection with the expiration or any termination of the Agreement.

9.6 No Interruption of Work. Notwithstanding anything that may be contained in the Agreement to the contrary, and regardless of whether or not the parties have availed themselves of the dispute resolution procedures described in **Article 14**, in no event nor for any reason whatsoever shall Contractor deny, withdraw, interrupt or restrict provision or receipt of the Work (including any Termination Assistance Services), disable any hardware or software used to provide the Work, or perform, or omit to perform, any other action that has the effect of preventing, impeding or reducing in any way the provision of Work or the ability of Company and its Affiliates to conduct their business activities, unless: (a) authority to do so is conferred by a court of competent jurisdiction; or (b) the Term of the Agreement has ended (and a transition satisfactory to Company has been completed).

9.7 Effect of Full or Partial Termination.

9.7.1 Payment Obligations. In the event of termination under this **Article 9**, Company agrees to pay to Contractor the Charges for Work satisfactorily performed by Contractor under the Agreement through the date of actual termination, but shall not pay other Charges or fees related to such termination, unless specifically described in this **Article 9** or elsewhere in the Agreement. If Company elects to partially terminate the Agreement, the Parties will equitably adjust downward the Charges payable under the Agreement for the remaining scope of Work for the duration of the Term of the Agreement.

9.7.2 Treatment of Credits Upon Termination. Any and all credits that have accrued under the Agreement, but have not yet been issued to Company as of the Termination Date, shall be paid to Company by Contractor within thirty (30) days following the Termination Date.

9.8 Cumulative Remedies. **T**he rights and remedies available under the Agreement are neither exclusive nor mutually exclusive, and the parties are entitled to any and all such remedies, and any and all other remedies that may be available to the parties at Law or in equity, individually or in any combination thereof.

9.9 Attorneys' Fees. If a party brings an action, proceeding or claim against the other party arising out of or relating to the Agreement, or pertaining to a declaration of rights under the Agreement, the trier of fact may, in the exercise of its discretion, award the party it finds to be the prevailing party in such action, proceeding or claim that portion or all of its fees, costs and expenses (including court costs and reasonable fees for attorneys and expert witnesses) that it deems to be appropriate under the facts and circumstances. The term "prevailing party" for purposes of this Section shall include a defendant or plaintiff, as applicable, who has by motion, judgment, verdict or dismissal by a court, successfully: (a) defended against any claim that has been asserted against it, in the case of a defendant; and/or (b) asserted any claim against a defendant, in the case of a plaintiff.

9.10 Survival. Any terms of the Agreement that, by their express terms or by their nature, may reasonably be presumed to survive any expiration or termination of the Agreement shall so survive including, without limitation, the following provisions of the Agreement: **Sections 1.2, , 4.3, 4.4, 4.5, 4.6, 4.7, 5.1, 5.2, 5.3, 5.5, 5.6, 6.1.1, 6.1.4, 6.1.5, 6.3, 9.7, 9.8, 9.9, 9.10,** and **12.4**, and **Articles 7, 8, 10, 11, 13, 14** and **15**.

ARTICLE 10 – TERMINATION/EXPIRATION ASSISTANCE WORK

10.1 Termination/Expiration Transition Plan. Contractor understands and agrees that Company's business operations are dependent on the Work, and that Company's inability to receive the Work would result in irreparable damages to Company. Therefore, upon the expiration of the Agreement or its termination by either party for any reason, including any breach of the Agreement by the other party, or the termination of any Purchase Order, Termination Assistance Services shall be provided as set forth in this **Article 10**. Within fifteen (15) days of either party's receipt of any notice of termination or notice of non-renewal of the Agreement, or two (2) days of termination of a Purchase Order, the parties shall Work together in good faith to develop a termination transition plan that is consistent with the requirements of

ATTACHMENT 4
TO SECOND AMENDMENT TO NATURAL GAS FACILITY INSTALLATION CONTRACTOR AGREEMENT

SCHEDULE 4.1
CHARGES

1 General. Each Purchase Order will provide whether the Work will be performed on a Project basis under a Project Work Detailed Specification or non-Project basis as Other Work. For Projects, Company will first submit a Detailed Construction Specification to Contractor for quotation. If Company awards the Project to Contractor, Company will issue a Purchase Order to Contractor for the Project. For Other Work, Company will either award the Work via a Purchase Order to Contractor following Company's submittal of a Project Work Detailed Construction Specification or other Work Detailed Specification to Contractor or via an annual blanket Purchase Order based on the Unit Pricing List and submit a work request or similar document to award Other Work for Contractor to perform under the blanket Purchase Order.

2 Pricing.

2.1 Project Work. Payment and invoicing for Project Work performed will be done on a percent completion basis based on Lump Sum Pricing. Except that the Company may provide for adjustments to the Lump Sum Pricing in a Detailed Specification for uncertainty or variations in field conditions or actual facilities. Except for adjustments specifically provided for in a Detailed Specification, Contractor shall not vary the Work or charge the Company for any extra until Company has approved a Change Order subject to the provisions of Article 4 of this Agreement. On a monthly basis, based on the percentage of Work completed to date as detailed on the monthly invoice, the Contractor will be paid ninety percent (90%) of the invoiced and completed Work and upon completion and Company approval of all Restoration in a Phase, the Contractor will be paid the remaining ten percent (10%) of the Phase Lump Sum Pricing.

2.2 Other Work.

2.2(a) Unit Pricing List. In consideration of Contractor's performance of the Other Work, the Company agrees to pay Contractor a price in accordance with the Unit Pricing List attached as Exhibit 3 to the Agreement ("***Unit Pricing List***").

2.2(b) Non-Unit Pricing List. In the event that a Purchase Order or Work request requires Other Work of a type not included in the Unit Pricing List, Contractor shall prepare and submit a price or prices for such Work to Company. Where a Purchase Order necessitates the preparation and submission of a special price or group of prices, Contractor shall not commence Work pursuant to such Purchase Order until Company has approved a Change Order.

2.3 Adjustments to Prices. The Unit Pricing List, included as Exhibit 3, shall remain in effect for all Work performed through December 31, 2013. Contractor may, as provided herein, propose annual price adjustments for Work ordered from January 1 through December 31 of the each subsequent year. Any proposed increase must be submitted in writing, no later than thirty (30) days prior to the date upon which such adjusted prices are proposed to take effect. All proposed increases must be accompanied by complete and creditable support, acceptable to the Company, for all elements of cost. All proposed price adjustments are subject to negotiation, and shall not take effect until agreed to in writing between the Company and the Contractor.

The Peoples Gas Light and Coke Company
Docket No. 16-0376
Response to the Illinois Attorney General's 4th Set of Data Requests
Date of Requests: August 26, 2016

REQUEST NO. AG 4.17:

Does PGL use Optimain DS (http://www.opvantek.com/index.php/products/optimain-suite/optimain-ds/) or a functionally equivalent software package to analyze the risk attributes of its distribution system? Please describe in detail whatever functionally equivalent software package the Company is using. If the Company is not using a functionally equivalent software package to Optimain DS, please describe all decision processes the Company undertook in electing not to use such a software package.

RESPONSE:

Not at this time. Peoples Gas recognizes that improvement is a continuous process and is currently investigating third party GIS software to display and analyze distribution integrity management plan (DIMP) data geographically. Peoples Gas has met with several vendors to review different software packages that are available and plans to utilize this software in the future.

Person(s) Responsible:

Thomas Webb -- Manager, Compliance

REQUEST NO. AG 11.03:

Please refer to the Company's response to data request AG 4.17, and respond to the following:

a. Please identify by name the software packages reviewed.
b. For each package identified, please state when the vendors made presentations to the Company.
c. Please provide copies of any promotional materials or presentations from the vendors.
d. Please provide an update on the Company's process for evaluating the software packages along with a timeline for decisions.
e. Please provide a copy of any RFP(s) and responses the Company has issued in connection with upgrading its software systems for a risk-based system like Optimain or functionally equivalent packages.

RESPONSE:

a. Peoples Gas has met with the following companies:
    - Opvantek regarding their OptimainDS and Optimain xDR software
    - Sure Power Consulting regarding their Distribution Integrity Management Program (DIMP) solutions that optimizes Geographic Information System (GIS)
b. Peoples Gas met with Opvantek on two separate occasions, October 19, 2015 and November 10, 2015. Peoples Gas met with Sure Power Consulting on January 7, 2016.
c. Please visit each vendors website for any promotional and presentation materials.
    1. http://www.opvantek.com/
    2. http://surepowerconsulting.com/
d. Peoples Gas is in the process of evaluating the software packages.
e. Peoples Gas has not yet issued a request for proposal.

Person(s) Responsible:

Thomas Webb -- Manager, Compliance

REQUEST NO. AG 11.07:

For the test year in the Company's last rate case (Docket Nos. 14-0224/0225 (cons.)), identify the criteria the Company used for unit of property accounting to distinguish between capitalizable and non-capitalizable expenditures associated with mains and services work. Include in the criteria the measures used for mains and service segments.

RESPONSE:

The test year (2015) in Docket Nos. 14-0224/14-0225 (cons.) did not include AMRP/SMP capital costs.

Peoples Gas has identified its own retirement units of property for each plant account in accordance with the ICC Uniform System of Accounts. The retirement unit defines which utility assets will be capitalized. The general rule is unless the entire retirement unit of property is being replaced, or in the case of a new asset, a new retirement unit of property is established, the costs would generally be expensed. An item must meet the following basic capitalization rules before an asset will be capitalized:

An expenditure will be capitalized if:

- The life of the item will be greater than one year.
- It is a replacement of the entire unit of property and not just an element of a retirement unit.
- A repair or replacement meets the criteria of costs to capitalize (i.e., value, capacity, or life of the existing asset is increased).
- The cost is not for what would be considered normal repair and/or maintenance.

Specifically for mains and service segments, the "50 foot rule" applies: if 50 feet or less of pipe is replaced then it is expensed on all like-type and -size replacements for gas mains and services. If it is not a replacement of like-type or -size pipe or it is new for the first time, it is capitalized down to the 1st foot. Services are tracked by footage and not by unit.

Person(s) Responsible:

Christine Gregor -- Manager, Operations Accounting

The Peoples Gas Light and Coke Company
Docket No. 16-0376
Response to the Illinois Attorney General's 11th Set of Data Requests
Date of Requests: September 23, 2016

REQUEST NO. AG 11.08:

For the AMRP and SMP, identify the criteria the company uses or will use for unit of property accounting to distinguish between capitalizable and non-capitalizable expenditures associated with mains and services work. Include in the criteria the measures used for mains and service segments.

RESPONSE:

Peoples Gas objects to the request that it identify the criteria it "will use" for unit of property accounting because the question is speculative. Peoples Gas has no way of knowing whether or how such criteria may change in the future. Please see the response to AG 11.07 for the current capitalization criteria.

Person(s) Responsible:

Christine Gregor -- Manager, Operations Accounting